Financial Attractiveness

Purpose

Financial attractiveness is the second major consideration in assessing water quality trading potential in your watershed. This chapter reviews the financial relationships affecting the viability of trading. The potential economic gains associated with trading are influenced by factors specific to the watershed as well as factors external to the watershed. Because the relevant financial relationships are often nuanced and dynamic, this section can offer only the foundation needed to begin examining current financial relationships in the watershed and their sensitivity to different assumptions. This chapter will help answer the following questions:

- What makes water quality trading financially attractive?
- How can I measure financial attractiveness?
- Where can I find the data?
- What could the analysis mean for my watershed?
- What should I do next?

After reading this chapter, considering the examples provided, and employing the tools or methodologies discussed, the watershed participant will be able to screen out unlikely trading scenarios and make an informed decision as to whether further pursuit of pollutant trading is warranted. Although this chapter discusses detailed calculations, a rigorous analysis will not typically lead to a definitive answer. However, the reader will be able to locate an individual trade’s position along a relative continuum of financial attractiveness, from “high” to “low”. This chapter will also help improve the reader’s ability to discuss water quality trading with other watershed participants by creating a common “language” to describe their needs and issues. In watersheds across the country, people are talking with one another and developing new, non-traditional ways to “trade” and solve their problems. Understanding the financial challenges potential trading partners face can help you identify such opportunities in your watershed.

Approach

This chapter reviews the primary drivers of financial attractiveness and describes the steps for conducting an analysis to assess those drivers in a specific situation. First, the Handbook suggests investigating a discharge source for which the necessary data are relatively accessible. The investigation includes building a basic model assessing the source’s current and future costs for controlling the relevant pollutant(s). With this basic understanding of the financial considerations for one source, the reader is encouraged to compile data for other sources in the watershed. Data collection strategies and data formatting are considered. Finally, this chapter details the factors that influence the strength of financial attractiveness and how to incorporate them into an analysis.

Possible barriers to a viable trading market are discussed. Certain types of trades will present themselves as relatively straightforward, easy to execute, and financially beneficial to all parties. Other potential trades will be more difficult and may not result in cost savings. For example, two point sources of phosphorus, located a quarter-mile apart, and facing large differences in their control costs likely will uncover a compelling case for trading. On the other hand, two sources at opposite ends of a complex watershed, attempting to control temperature, and sharing only moderately different control costs are unlikely to obtain any advantages from trading. The ability to differentiate scenarios systematically will help watershed participants use trading wisely as a tool to improve water quality at lower cost. Throughout this chapter, the Happy River Basin hypothetical will be used to illustrate the analytical process and some of the common barriers.

The economic models, financial models, and analysis techniques provided in this chapter are, by design, very basic. They will help you screen your watershed for financial attractiveness at a very general level and provide you with the basic ability to gauge whether you have low, medium, or high financial opportunities. Pilot projects have indicated that conducting more precise and in-depth analysis will typically involve a substantially increased level of effort and will quickly move outside the realm of readily available data. The tools provided in this chapter have been well tested, do not require sophisticated economic modeling skills to implement, and are fully sufficient for basic screening purposes. More precise analysis will typically require in-depth interaction with individual discharge sources and may quite quickly encounter barriers related to proprietary business information. As a result, this more in-depth work will often be best conducted by individual sources in the context of specific trade negotiation activities.

What Makes Water Quality Trading Financially Attractive?

The financial attractiveness of pollution trading is created by differences in the pollution control costs faced by individual dischargers. These differences may make it possible to improve water quality at lower cost overall by allowing pollution dischargers facing high control costs to pay dischargers with lower cost control options to "overcontrol" their discharges. "Overcontrol" as used herein means reducing a pollutant discharge below the target load specified by the watershed's market driver (typically a TMDL). The volume of reduced discharge below obligations represents the stock of potential surplus reductions available for exchange with other parties. Pollution overcontrol creates a "product" with buyers and sellers in a potentially competitive market that can encourage innovation and efficiency untapped by a conventional regulatory regime.

To assess trading viability, a common measure is needed to assess the costs each discharger will face to comply with its requirements. Chapter One explained the need to identify a tradable commodity. Moving on to calculate the cost of producing the commodity in the form of surplus pollution reductions will show whether the relative cost efficiency of some dischargers' control options can lead to economically efficient trades. Some pilot projects have used "incremental cost of control" as the common measure. Incremental cost of control is calculated as the average cost of control *for the increment of reduction required for an individual source to achieve compliance*. For example, if a discharger needs a 5 lbs./day reduction to comply but the only reasonably available technology costs $10 million and produces a 20 lbs./day reduction, then the incremental cost associated with the 5 lbs./day reduction is substantial relative to the average cost of reductions. Traditional average cost would divide costs by 20 lbs./day; incremental analysis divides the costs by 5 lbs./day and would be four times higher than average cost. As discussed earlier, incremental cost represents a good approximation of the upper-bound of a source's willingness to pay others within their watershed to alter their discharging behavior.

STAGE 1: CALCULATING INCREMENTAL COST OF CONTROL FOR A SINGLE SOURCE

The first step to assess financial attractiveness is to calculate the incremental cost of control for each pollution source. You may have ready access to needed data for at least one source. (Gathering information from other sources is discussed later.) The following data are needed to calculate incremental cost of control:

- The source's current load;
- The source's TMDL (or equivalent) target load;
- The source's projected load on its required compliance date if no controls are implemented;
- The source's projected long-term future load (considering anticipated growth and other relevant factors);
- Annualized cost of the control option(s) including capital investment and annual operating and maintenance (O&M) costs; and
- Expected reductions achieved by the control option.

Calculating the incremental cost then involves the following tasks.

Task 1: Calculate Required Reductions

A facility's future discharge will be influenced by any changes in demand for the facility's primary services or products (e.g., municipal sewage treatment, industrial production, or agricultural production). For a publicly owned wastewater treatment plant, discharge will likely vary as local population increases and/or the number and activity level of industrial users changes. Industrial sources may discharge more as production rises. An increase (or decrease) in discharge (and resulting reductions needed to maintain compliance) will affect needed reductions, incremental cost of control and, potentially, the financial attractiveness of trading in the watershed.

The reductions needed to comply equal the discharger's target pollutant waste load minus its current loads and any expected future loading increases. Both the projected load at the compliance date and the projected long-term future load should be calculated. Compliance dates and capital budgeting interact with changing demand to influence discharge control choices; therefore, multiple timeframes may require examination. The motivation for cost savings will materialize when a looming compliance date presents the possibility of enforcement and penalties if discharges are not reduced. Currently, NPDES permits implement TMDLs for point sources and typically give sources three to five years to control their discharge. This normally gives dischargers a window of opportunity to evaluate their options, select the best alternative, and implement it. In the Happy River Basin hypothetical, the NPDES permit holders have five years to comply.

Water pollution control technology often represents a significant, fixed, long-term capital investment. If a discharge increases beyond the existing control technology's ability to maintain compliance during its useful life, new investments may be required in the future. Sources therefore need to examine the implications of their available options over an extended period.

In the hypothetical, the sources project discharge volumes in five years for compliance requirements and in ten years for capital budgeting needs. Future discharge levels can be difficult to estimate. For the purposes of analysis, it may be best to create several scenarios with different levels of anticipated growth. Past pilot projects have used a system of "High," "Moderate," and "Low" growth trends. Current pollutant loadings may be estimated to increase at a constant rate over a specified period to estimate future loads and future required reductions.

Hopeville's Incremental Cost of Control

Projecting Hopeville's Needed Reductions
The Hopeville POTW currently discharges, on average, 4.1 million gallons of wastewater per day. Routine sampling results show that the Total Phosphorus (TP) concentration in the effluent is 2.99 milligrams/liter. Converting gallons into liters and milligrams into pounds, the POTW's current TP load is 62 lbs./day[3]. POTW managers believe their system could face demand increases between 1 percent and 8 percent, on average, over 10 years. Hopeville believes that a reasonable assumption is that moderate population and industrial growth will increase its TP load 3 percent annually over the next five years to 72 lbs./day. The TMDL assigns Hopeville a waste load allocation, or Target Load, of 50 lbs./day and this is an enforceable compliance requirement in its permit. The following table summarizes needed reductions at today's current discharge, five years from now at the time permit compliance is required, and ten years in the future assuming 1 percent, 3 percent, and 8 percent annual growth.

As shown in the table, Hopeville needs to consider a wide range of potential reductions to meet its permit under the TMDL. At current discharge levels, the POTW needs to reduce TP discharge by 12 lbs./day. Five years from now, when failing to comply has real economic consequences, Hopeville will need to have reduced its TP discharge by between 16 and 42 lbs./day, depending on demand for its services. Looking further into the future, Hopeville will need to generate between 19 and 84 lbs./day of TP reductions to remain in compliance. For the purposes of examining financial attractiveness, you will focus on reductions needed in five years for compliance and assume that Hopeville will experience moderate growth. Therefore, the assumption is that Hopeville will be generating 72 lbs./day of TP and will have to reduce that discharge by 22 lbs./day in five years.

[3] 1lb = 453592.37 milligrams and 1 gallon =3.785411784 liters

Figure 2.1, Hopeville's POTW Load Projections

Hopeville POTW Load Projections (lbs./day)				
Current Discharge	Annual Growth	TP Load	Target Load	Reduction Needed
Current Baseline				
62	0%	62	50	12
5 years (Compliance Date)				
62	1.0%	66	50	16
62	3.0%	72	50	22
62	8.0%	92	50	42
10 years (Capital Budgeting)				
62	1.0%	69	50	19
62	3.0%	83	50	33
62	8.0%	134	50	84

Task 2: Examine Control Technology Options

The next task is to examine available technologies' ability to control the pollutant discharge and the associated costs. Multiple technologies and mitigation approaches may be available to each source to help address water quality impairments. The cost and efficacy of control options varies. Usually, more control equals greater cost. Moreover, current control technology often achieves reductions by removing pollutants in large increments. Some control technologies will, therefore, produce the needed reduction increment and a (significant) additional increment for little or no additional cost. As control needs increase past the technology's ability to control pollution, the facility may need to invest in more control and/or take the next "technology step."

Hopeville's Technology Options
Hopeville's wastewater treatment engineers have identified three technologies that could reduce phosphorus discharge from their POTW and offer a range of control. Advanced Primary Treatment (APT) is capable of removing 16 lbs./day. After an investment in APT, the next "step" is Biological Nutrient Removal which would remove an additional 24 lbs./day. Finally, additional aeration basins and secondary clarifiers would eliminate 55 lbs./day of additional total phosphorus.

Task 3: Calculating Incremental Reductions Needed for Compliance

When a technology step (or combination of steps) fails to generate, at a minimum, the total reduction needed, a source may be forced to consider investment in an additional technology step, even though this would produce more reductions than are needed. To evaluate its options, Hopeville generated the following table for its 5-year projection.

Figure 2.2, Hopeville's POTW 5-Year Projection

Hopeville POTW 5-Year Projection (lbs./day)							
	Low Growth						
	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reductions Needed for Compliance
	1.0%	66	50	16			
Step 1					16	16	0
Step 2					22	38	N/A
Step 3					30	68	N/A
	Moderate Growth						
	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reductions Needed for Compliance
	3.0%	72	50	22			
Step 1					16	16	6
Step 2					22	38	N/A
Step 3					30	68	N/A
	High Growth						
	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reductions Needed for Compliance
	8.0%	92	50	42			
Step 1					16	16	26
Step 2					22	38	4
Step 3					30	68	N/A

Hopeville's Incremental Reductions Needed for Compliance

Under low growth assumptions, Hopeville faces a reduction need of 16 lbs./day. As the table demonstrates, APT generates 16 lbs./day of reductions, the exact volume of reductions required by the TMDL. If the POTW implemented this control technology, compliance would be reached and there would be no incremental reductions needed. However, under moderate growth estimates, the TMDL would require Hopeville to reduce its discharge by 22 lbs./day. The difference between the reductions achieved with APT (16 lbs./day) and the total reductions needed (22 lbs./day) would equal 6 lbs./day. These represent the incremental reductions needed for compliance. Similarly, under high growth assumptions, implementing APT and Biological Nutrient Removal would generate 38 lbs./day of reductions, while Hopeville would be required to reduce its TP discharge by 42 lbs./day. Under these assumptions, the POTW would fall short of compliance and need 4 lbs./day of incremental reductions.

Task 4: Calculating Annualized Control Costs

To estimate the anticipated annualized cost of each control option, you will need to total the annualized capital cost and the annual O&M cost.

- Annualized capital cost is the total cost (including associated finance charges) incurred for installing a control option divided by the control option's useful life.
- Annual O&M cost should include but not be limited to monitoring, inspection, permitting fees, waste disposal charges, repair, replacement parts, and administration.

The following worksheet describes the calculations[4]:

Calculation of Annualized Control Costs		
Cost of Installing Control Option	________	(1)
Time Period of Financing (Expressed as years)	________	(n)
Interest Rate for Financing (Expressed as a decimal)	________	(i)
Annualization Factor*	________	(2)
Annualized Capital Cost [Calculate (1)x(2)]	________	(3)
Annual Cost of Operation & Maintenance**	________	(4)
Total Annual Cost of Control [(3)+(4)]	________	
* Appendix D contains the Annualization Factor for a range of interest rates and time periods		
** For recurring costs that occur less frequently than once a year, pro rate the cost over the relevant numbers of years (e.g., for pumps replaced once every three years, include one-third of the cost in each year).		

The appropriate interest rate will depend on the facility's ability to access financing. Public treatment works may have access to grants and revolving funds designated for water quality infrastructure improvements. Currently, the EPA and state funded Clean Water State Revolving Fund issues loans at rates between 0 percent and market rates, with approximately 2.5 percent being average. In some circumstances, certain private entities are also eligible for loans from these below market funds. Borrowers from the capital markets currently face interest rates of approximately 6 percent.

[4] As previously mentioned, the models and tools in this chapter provide you with general screening capabilities. In certain cases, an investment made in control technologies may be phased in over several years. This potentially affects your annualized cost calculation. When analyzing a phased investment, the precision of your analysis will increase by appropriately modeling each phase of the project and summing the individual results in a logical manner.

Hopeville's Annualized Control Costs
Hopeville is analyzing its control costs based on installing APT. The equipment costs $332,468 to install (1) and will be financed through a municipal bond backed by Hopeville's water and sewer fees over a 10-year period (n). Currently, similar bonds issued by comparable municipalities pay 4.5 percent (i). The Annualization Factor for a 10 year financing period at 4.5 percent is .1264 (2); therefore the annualized Capital Cost equals ($332,468) multiplied by (0.1264) or $42,024 per year (3). The O&M costs for this option are estimated to total $14,008 (4) annually. Therefore it will "cost" the POTW $56,032 each year to control their discharge and maintain compliance by investing in APT.

Task 5: Calculating Incremental Control Cost

The final task is to divide annualized costs by the incremental reductions needed for compliance. This should be done for each relevant time period (e.g., 5 years and 10 years) under each growth scenario. Hopeville analyzed its three options for the POTW and produced the following table for its five-year projection.

Figure 2.3, Hopeville's POTW 5-Year Projection Including Costs

Hopeville POTW 5 Year Projection (lbs./day)										
	Low Growth									
Control Option	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reduction Needed for Compliance	Control Increment Capital/O&M Incurred Annualized	Incremental Control Cost	Average Control Cost
	1.0%	66	50	16			16			
Step 1					16	16	0	$56,032	$9.59	$9.59
Step 2					22	38	N/A	$219,022	N/A	$27.28
Step 3					30	68	N/A	$339,450	N/A	$31.00
	Medium Growth									
Control Option	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reduction Needed for Compliance	Control Increment Capital/O&M Incurred Annualized	Incremental Control Cost	Average Control Cost
	3.0%	72	50	22			22			
Step 1					16	16	6	$56,032	N/A	$9.59
Step 2					22	38	N/A	$219,022	$100.01	$27.28
Step 3					30	68	N/A	$339,450	N/A	$31.00
	High Growth									
Control Option	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Cumulative Reduction Achieved	Incremental Reduction Needed for Compliance	Control Increment Capital/O&M Incurred Annualized	Incremental Control Cost	Average Control Cost
	8.0%	92	50	42			42			
Step 1					16	16	26	$56,032	N/A	$9.59
Step 2					22	38	4	$219,022	N/A	$27.28
Step 3					30	68	N/A	$339,450	$232.50	$31.00

Hopeville's Incremental Control Cost
As noted earlier, Hopeville's "Step 1" control option generates the exact number of reductions needed for compliance under low growth assumptions. Therefore, the incremental control cost for Step 1 is equal to $56,032 (the annualized cost) divided by 16 lbs./day (the incremental reduction needed for compliance with no additional control) or $9.59/lb./day.[5] If the city experiences medium growth over the next five years, Step 1 will fall 6 lbs./day short and force Hopeville to implement both Step 1 and Step 2. The incremental control cost for Step 2 is equal to $219,022 (the annualized cost of Steps 1 and 2) divided by 6 lbs./day (the incremental reduction needed for compliance using Step 1 control) or $100.01/lb./day. However, Step 1 and Step 2 together would not produce compliance under a high growth scenario. Consequently, the incremental control cost would be $339,450 (the annualized cost of Steps 1, 2, and 3) divided by 4 lbs./day (the incremental reduction needed for compliance using Steps 1 and 2) or $232.50/lb./day.

STAGE 2: *EXAMINING THE WATERSHED*

As already discussed, the goal of water quality trading is to take advantage of differences in incremental control costs among sources in a watershed by allowing facilities facing higher costs to compensate those who can produce reductions at lower cost, thereby producing the same (or more) environmental benefit with less overall cost to society. Analyzing incremental costs for all dischargers in a watershed may be seen as a premature segmentation of the market into high cost reduction producers (likely buyers) and low cost pollutant reducers (likely sellers). However, at this time, the main focus of analysis should be to characterize the size of the incremental control cost differences present in your watershed. The differences in incremental control costs may be consumed by other financial and market factors that are discussed in Stage 3. At this time, you are concerned only with identifying the range of differences present based on different growth assumptions.

Compiling Information from Other Sources

The potential advantages of trading may motivate a variety of actors, both public and private, to investigate trading opportunities in the watershed. Analyzing trading potential therefore may involve compiling information from many sources, including family farms, POTWs, and publicly traded corporations. These potential market participants, while under pressure from the same market driver (e.g., the need to meet a TMDL allocation), may have different motivations for discussing water quality trading. In addition, incentives to share information with outsiders, like regulators or environmental groups, may vary. Engendering trust and being creative may help in acquiring needed data. (For example, Appendix E is a sample data sheet distributed to pollutant sources participating in a pilot project. This information was then compiled into spreadsheets used for a market assessment.)

[5] Most pilot projects have chosen to denominate their costs in dollars/pound/day. Accordingly, the table divides the annualized control cost by 16 lbs. and 365 days. $56,032/16 lbs./365=$9.59.

Public Point Sources

Ability to gather the needed control cost information for POTWs or other public point source dischargers is likely enhanced by public disclosure and information laws. Citizens are often entitled to obtain a wealth of information including planning documents and discharge data from individual industrial dischargers to the public system. Often, public facilities have required planning cycles for projecting future demands for service and preparing to cost-effectively manage community infrastructure needs. In addition, working directly with the POTW to obtain the pertinent information may help develop relationships beneficial to future trading efforts.

Private Point and Non-point Sources

Soliciting information from private sources is more challenging. Creating a water quality trading market is an unconventional approach to improving water quality which explicitly depends on the potential benefits of trading in a given watershed. In conventional markets, cooperation evolves during the exchange of goods and services when buyers indicate their willingness to pay and sellers exhibit their willingness to accept. Consequently, in a traditional market, information sharing is usually limited to negotiating a specific transaction. Analyzing the financial attractiveness of water quality trading requires sharing information prior to negotiating trades. The desired information includes potential reduction costs, which could give competitors clues about a facility's future strategic plans. Wide dissemination of this information could reduce competitive advantages currently enjoyed by the local facility. In addition, detailed information on cost, market supply, and market demand for pollutant reductions may allow other market participants to capture larger shares of trade benefits. Therefore, both the information required to develop the watershed trading financial analysis and the results of that analysis may be perceived as potentially leading to financial losses.

Private entities may be understandably reluctant to provide information considered business sensitive. It is even possible that some entities may attempt to secure bargaining power by providing inaccurate cost information. This could allow them to buy reductions at a price lower than their willingness to pay or selling reductions at prices higher than their actual willingness to accept. Although these incentives may muddy the financial analysis, private sources are unlikely to game themselves out of participating in a water quality trading market.

Sources for Non-Point Source Cost/Pollutant Reduction Information

In many cases, non-point sources have access to information resources pertinent to their likely costs. If they are unwilling or unable to share the information, non-point cost and pollutant reduction information will likely have to be pieced together from a variety of sources. Some trading pilot projects, like Tar-Pamlico in North Carolina, have completed studies and published them on the Internet. Other information sources include the U.S. Department of Agriculture's Natural Resource Conservation Service, Agricultural Research Service, and agricultural extension programs at colleges and universities.

Putting the Information Together

As more dischargers are included in an analysis, complexity increases. The key to organizing the information is to ensure an "apples to apples" comparison. As discussed in the previous chapter, annual and seasonal TMDL allocations are often implemented through NPDES permit limits with daily, weekly, or monthly compliance metrics. In the hypothetical, as in many pilot phosphorus trading projects, the pollutant is measured in pounds per day. Although translating between any two metrics is possible, you should verify that the analysis employs a common numerator and denominator for all sources. The format used below to analyze incremental cost of control in the hypothetical has been used in pilot trading programs. It is always wise, however, to tailor the format for the analysis according to the needs and skills of watershed participants.

A Financial Snapshot of the Happy River Watershed

Combining the Needed Data

Hopeville and its fellow sources exchanged the needed information and produced the following spreadsheet, cataloging each source's incremental control cost in five years under a moderate growth scenario. Sources are listed from upriver to downriver and all possible technology steps for each source are listed.

Figure 2.4, Happy River Watershed Combined Analysis

	Medium Growth 5 Year Projection (lbs./day)										
Facility	Annual Growth	TP Load	Target Load	Total Reduction Needed	Reduction Achieved	Total Reduction Achieved	Incremental Reduction Needed for Compliance	Control Increment Capital/O&M Incurred Annualized	Incremental Control Cost	Average Control Cost	Potential Surplus Reductions Available to Market
Pleasantville	3.0%	917	633	284							
Step 1					662	662	N/A	$ 2,074,237	$20.01	$8.58	378
Step 2					107	769	N/A	$ 5,222,364	N/A	$133.72	485
Herb's Farm	3.0%	873	527	346							
Step 1					91	91	255	$ 49,823	N/A	$1.50	None
Step 2					623	714	N/A	$ 464,444	$4.99	$2.04	368
Acme Inc.	5.0%	698	410	288	506	506	N/A	$ 6,308,251	$60.01	$34.16	218
Hopeville	3.0%	72	50	22							
Step 1					16	16	6	$ 56,032	N/A	$9.59	None
Step 2					24	40	N/A	$ 219,022	$100.01	$27.28	18
Step 3					55	95	N/A	$ 339,450	N/A	$31.00	73
AAA Corp.	7.0%	274	166	108	163	163	N/A	$ 590,906	$14.99	$9.93	55

STAGE 3: *ANALYZING THE RESULTS*

Task 1: Identifying Potentially Viable Trades

The format used to compile incremental control cost information for the hypothetical watershed allows watershed participants to analyze a one-to-one pollution reduction purchasing relationship. The next step is to identify potentially viable trades. As demonstrated in the 5-Year Medium Growth Projection, the incremental control costs ($/lb), in descending order, are:

- Hopeville $100.01;
- Acme $60.01;
- Pleasantville $20.01;
- AAA Corp. $14.99; and
- Herb's Farm $4.99.

Because trading allows facilities facing higher reduction costs to compensate those with lower reduction costs, sources theoretically would consider trading with any source below them on the list. Using this simple assumption, the following nine possible transactions appear to be financially attractive:

- Hopeville compensates Acme Inc. to overcontrol;
- Hopeville compensates Pleasantville to overcontrol;
- Hopeville compensates AAA Corp. to overcontrol;
- Hopeville compensates Herb's Farm to overcontrol;
- Acme compensates Pleasantville to overcontrol;
- Acme compensates AAA Corp. to overcontrol;
- Acme compensates Herb's Farm to overcontrol;
- Pleasantville compensates AAA Corp. to overcontrol;
- Pleasantville compensates Herb's Farm to overcontrol; and
- AAA Corp. compensates Herb's Farm to overcontrol.

Task 2: Detailed Analysis

Although the Preliminary Analysis may identify potential trades, assessing financial attractiveness on this basis alone requires making several assumptions. (The previous chapter discussed how unlikely some of these assumptions may be.) For example, one would have to assume that:

- The effectiveness of the control technology selected is not variable;
- Reductions in all locations in the watershed are environmentally equivalent;
- Transaction costs are zero;
- Reductions are certain to occur; and
- The timing of all reductions will coincide with compliance mandates.

The financial attractiveness of a trade is subject to deterioration as these and other complicating factors are included in the analysis. Pilot project experience indicates that an organized analysis is needed to add the relevant additional considerations as an overlay to the preliminary analysis. These additional considerations (discounts, ratios, transaction costs, and risk) are best investigated in ascending order of complexity. As each consideration is added to the analysis, the stakeholder can decide whether further effort to create a trading market is warranted. If the incremental cost differences become very small, thereby substantially reducing financial attractiveness, watershed participants may decide that trading is not viable. If a reasonable level of financial attractiveness remains, additional factors can be considered.

Uncertainty Discount Adjusted Incremental Control Cost

Two types of pollutant reductions have been identified in pilot projects and the literature—measured reductions and calculated reductions. Certain control technologies result in easily measured water quality improvements; ongoing monitoring effectively quantifies the actual reductions achieved. In some cases, however, measuring a control option's impact on pollutant loading is either infeasible or very costly. Reductions for these control options are often estimated based on scientific modeling for the watershed. Loading reductions from Best Management Practices (BMPs) used by non-point sources are most likely to be calculated.

BMPs perform differently based on a variety of site specific factors that may not be included in the model, introducing the chance for variable and unpredictable results. In pilot projects, the relatively variable and unpredictable performance of BMPs has been handled by discounting the associated estimated reductions available for trade. The uncertainty discount ensures that estimate errors in the BMP reduction equation (derived from the model) will not jeopardize the environmental equivalence between different types of pollutant reduction methods. The size of the discount will likely be driven by local conditions with input from stakeholders. To measure the uncertainty discount's effect on the financial attractiveness of individual trades, you will need to recalculate the source's incremental cost of control using the discounted reductions.

Analyzing the Happy River Watershed

Pleasantville and Herb's Farm

Herb's Farm can use its Step 1 and 2 control options -- sediment ponds and constructed wetlands – to control discharges from its fields and trade the overcontrol to Pleasantville. Research shows that, on average, these options could reduce phosphorus loadings from the farm by 623 lbs./day. At an annualized cost (based on the length of the growing season when the farm can generate reductions) of $464,444 the incremental control cost for Step 1 is $4.99/lb./day[6]. However, reductions by Herb's Farm are likely to vary based on its unique (and sometimes unknown) characteristics. It would be too costly to measure the actual phosphorus reduction achieved on a daily basis. Potentially, stakeholders could ask that an uncertainty discount factor be applied to the projected reductions achieved. A 50 percent discount would mean, in effect, that the farm must produce 2 lbs. of projected reductions for every 1 lb. it wishes to trade. Consequently, from Pleasantville's perspective, the total cost of achieving its needed increment of control through trading will increase because it will need to purchase more credits to achieve an environmentally equivalent reduction. The price per pound of reduction increases from $4.99 to $9.98, modestly eroding the financial attractiveness of a trade between Herb's Farm and Pleasantville.

[6] The cost per pound per day is based on the same incremental costs analysis performed for Hopeville. As per Figure 2.4, Herb's Farm Step 1 reduces discharge by 91 lbs. The farm would need an additional increment of 255 lbs. to comply with the TMDL. As such, to calculate the incremental control cost, the annualized cost for Steps 1 and 2 ($464,444) must be divided into 255 lbs.

Environmental Equivalence Ratios

The water quality impact of a pollutant discharge varies depending on its location in the watershed. As discussed in the previous chapter on Pollutant Suitability, a discharge's impact depends on the pollutant's fate and transport as well as hydrologic conditions in the watershed. Environmental equivalence ratios must sometimes be established to ensure that the overall pollutant load does not impair beneficial uses of the river at specific monitoring points. But ratios can be distributed within a market to find the least cost pathway to achieving the load goal.

Pilot projects have used different environmental equivalence ratio methodologies ranging from the simple to highly complex. Some have used a simple fixed ratio (i.e., 2-1) for all trades. Others have created an index system based on a mass balance model that accounts for inputs, withdrawals, and groundwater infiltration. In these systems, a compliance point downstream is used to index the fate and transport of the pollutant from upstream sources. Dividing Source A's index by Source B's index determines the ratio of reductions Source A would have to buy from Source B.

Because these ratios can compare environmental equivalence only between two sources, it is difficult to present a comprehensive analysis of their effects on the financial attractiveness of trading for the whole watershed in a single spreadsheet. Watersheds with a large number of sources can be extremely complex. Ten potential trading sources would involve 54 trade permutations, many of which are not likely to prove viable. The goal of your analysis should be to identify "Alpha Trades," those with potentially significant financial gains, and, therefore, strong financial attractiveness even after environmental equivalence ratios are introduced. As suggested by the previous chapter, Alpha Trades are not likely to involve sources separated by significant distances or sources with significant water diversions in the stream segment separating them.

Alpha Trades that may merit analysis in the Happy River Watershed are:

- Hopeville compensates Pleasantville to overcontrol;
- Hopeville compensates Herb's Farm to overcontrol;
- Pleasantville compensates Herb's Farm to overcontrol; and
- Acme Inc. compensates Pleasantville to overcontrol.

Environmental equivalence ratios can have a profound effect on financial attractiveness. As the ratio between buyer and seller increases, the volume of purchased reductions to maintain compliance increases, driving the cost per unit of purchased reduction higher. Conversely, as the ratio between buyer and seller gets smaller, cost per unit of purchased reduction falls. The following hypotheticals illustrate various key nuances of this relationship.

Hopeville, Pleasantville, and Herb's Farm
Hopeville faces incremental control costs of $100/lb. Pleasantville is able to control for $20/lb. creating an incremental control cost difference of $80/lb. Financial attractiveness appears high assuming the reductions have an equivalent effect on water quality. However, as a mass balance model indicates, the long distance between the two sources and an intervening river diversion between create an environmental equivalence ratio of 5.0. Therefore, Hopeville must purchase 5

lbs. of reductions from Pleasantville for every 1 lb. of its own required reduction. The cost to Hopeville of a one pound reduction purchased from Pleasantville increases from $20 to $100, completely eroding any potential gains from the trade.

In contrast, Herb's Farm is able to overcontrol for $5/lb., creating an incremental control cost difference between Hopeville and the farm of $95/lb. The river diversion creates an environmental equivalence ratio of 3.0 between the POTW and the farm. Therefore, Hopeville must purchase 3 lbs. of reductions from Herb's Farm for every 1 lb. of its own required reduction. In this case, the unit cost to Hopeville of a one pound reduction purchased from the farm increases from $5 to $15. The difference between Hopeville's cost of controlling one pound of phosphorus or purchasing the environmental equivalent from the farm is ($100 minus $15) $85. This appears to be a highly attractive potential trade.

Pleasantville's close downstream proximity to Herb's Farm means that almost every pound of phosphorus the farm can remove from the river achieves more environmental benefits than if Pleasantville made the pollutant reductions itself. Mass balance modeling shows that Pleasantville needs to purchase only six-tenths (0.6) of a pound of overcontrol for every pound of reduction it needs. The cost to Pleasantville per pound of equivalent reduction purchased from the farm would be $3 rather than $5.

Acme and Pleasantville
Environmental equivalence ratios in downstream trades can reverse the relationship between higher and lower incremental control cost sources. Acme's index to the compliance point at the confluence of its tributary and the mainstem is (0.9). The large diversion downstream of Pleasantville means only a portion of the discharge from its facilities remain in the mainstem of the river at the compliance point. Pleasantville has received an index of (0.25). In this case, Pleasantville would need to buy a little over a quarter of a pound (0.25/.9=.2777) of reductions from Acme for every one pound of required reductions at its facility to lower the watershed's Total Phosphorus at the compliance point. This means the unit cost to Pleasantville of a one pound reduction purchased from Acme is approximately $16.66/lb. $3.34 less than the $20/lb. Step 1 would achieve at Pleasantville's own facility. Therefore, in this case, the lower cost producer of reductions may find it beneficial to purchase reductions from a higher cost source.

Transaction Costs

Transaction costs influence the financial attractiveness of a trade. Transaction costs represent all the resources needed to affect the trade, including information gathering, negotiation, execution, and monitoring. For a trade to be developed, at least one party must expend resources (usually time and effort) assessing the potential viability of the trade and communicating findings to the other party. To achieve the necessary "meeting of the minds," discussions with the other party and additional key stakeholders (i.e., regulatory agencies and local interest groups) must be undertaken. These negotiations may involve staff time, travel expenses, and legal fees. Costs are later incurred in monitoring compliance with trade agreements and maintaining communications with stakeholders.

It may be helpful to consider transaction costs in your financial attractiveness analysis. Transaction costs are highly variable, depending on such factors as the volume of trading, the infrastructure needed to facilitate trading, and the number and types of participants involved. Regulatory agencies may have significant influence on the relevant variables, and are therefore key controllers of transaction costs. Trading system designers must be attentive to the transaction costs they design into each trading arrangement. Failure to adequately take account of financial realities by controlling transaction costs can diminish or even eliminate the potential benefits of trading.

Several common tools can be used to estimate transaction costs. For example, Full Time Equivalents (FTEs) can be used to represent the salary and personnel overhead expenses of employees typically performing functions related to the trading market. In addition to assessing and negotiating a trade, employees will need to meet monitoring and reporting obligations related to the trade. New equipment needed for effluent and instream monitoring and data management may be needed and/or fees for laboratory analysis may be incurred. All these transaction costs of trading, along with the annualized capital and O&M cost for each control technology step, increase incremental control cost. To the extent that you are able to include these in your annualized costs, the precision of your in incremental control costs estimates will increase.

Risk

Risk is the final factor to consider in assessing the financial attractiveness of a trade. The first consideration is that efforts to create a trading system may or may not result in an approved trade. As already discussed, designing a water quality trade can be difficult and highly complex. The costs involved can be substantial. During initial design and negotiation, watershed participants are likely to reassess the chances of success continuously and will discount the value of a potential trade accordingly. For a trade to be viable, potential participants must believe that the financial benefits of the trade will be large enough to justify bearing the market risk. The timeliness and predictability of the decision processes prior to the first trade are therefore key leverage points to mitigate market risk and facilitate trading.

The other dimension of risk is trade risk. In a water quality trading market, one party must rely on other party(s) to fulfill its obligations. Agreed upon terms of a trade may or may not be performed by the parties. If agreed upon reductions are not achieved and NPDES permit requirements are thereby violated, the purchaser of those reductions may face legal enforcement and monetary penalties. In the context of water quality trading, trade risk represents the expected cost of non-compliance and the perceived probability that such non-compliance will occur. Currently no entity provides third-party insurance policies for water quality trading. Because they must self-insure, watershed participants will value trade risk subjectively and mitigate for it by discounting the price paid for available reductions.

The subjective valuation of trade risk limits your ability to estimate the trade risk markdowns watershed participants are likely to demand when negotiating a trade. At this point in your analysis, it may prove beneficial to discuss trade risk and the associated discounts with other watershed participants. Risk markdowns may be considerable in light of the large noncompliance penalties authorized by the Clean Water Act and the uncertainties surrounding trade risk.

As you begin to examine risk and transaction costs, you may wish to review the likely incremental cost differences between parties after uncertainty discounts and location ratios are considered. If a substantial difference remains, it is likely that risk and transaction costs will erode only a portion of the remaining financial attractiveness of a trade. If uncertainty discounts and location ratios have already significantly eroded the difference in incremental control costs, the remaining financial attractiveness may well be entirely consumed by transaction costs, market risk, and the buyer’s trade risk markdown.

Implications of Transaction Costs, Risk, and Market Design

Transaction costs and risk can be mitigated to some extent through thoughtful market design. Chapter 4 more fully describes the building blocks and key functions of a market and offers specific advice on how to tailor a market to its watershed's unique characteristics. Many stakeholders may be involved, each with different needs. A highly constructive stakeholder will focus on designing a market that meets, at a minimum, two goals: 1) reduced risk and 2) lower transaction costs. Transaction costs are largely associated with collecting and communicating information and obtaining agreements and regulatory approvals. To the extent that trading arrangements are transparent and frictionless, costs and risks associated with communication and understanding can be reduced. Similarly, transparency and the free flow of information create stable expectations and outcomes for market participants. With fewer lurking "unknowns", participants will feel less vulnerable in the marketplace and their required risk discount may shrink.

Other Important Factors

As you can see, the financial attractiveness of water quality trading may be highly nuanced by the considerations already addressed. Other factors may arise in your watershed based on its unique characteristics. The following are just two examples of watershed-specific considerations.

Market Size

Because pollution control technologies often produce reductions in large blocks, the water quality trading marketplace may be "lumpy". Depending on how much reduction a potential buyer needs relative to what technology can deliver, this can limit or enhance financial attractiveness. If a discharger needs one pound per day of reductions to comply, but the only available control technology is very expensive and will produce reductions well in excess of one pound per day, then that discharger's willingness to pay another party for that one pound of reduction could be very strong. On the other hand, if the same discharger needs 200 lbs./day, they will only be willing to purchase reductions if the entire 200 lb. reduction is reliably available. If that 200 lb. reduction is available only from diffuse sources with small individual surplus reductions, the associated transaction costs and risks may be so significant that trading is not viable.

Missing the Market

The ratio of fixed to variable costs associated with control options, combined with the timing of reduction demand and supply, will affect the financial attractiveness of a trade. If the discharger's control option involves relatively high fixed costs, the incremental costs of control will differ dramatically before and after investment in that control option. Before investment, a potential reduction purchaser will calculate the incremental cost of control as the combination of the amortized fixed and the annual variable costs of control. Once the discharger invests in high fixed-cost controls, those fixed costs are "sunk" and he will calculate the incremental cost of control based only on his annual variable costs. As a result, any trades that were financially attractive before the investment, will have a greatly diminished incremental cost differential after the investment and may actually represent a negative financial return.

It is especially important to consider the fixed/variable cost profile in cases where supply will lag behind demand. In such situations, the potential reduction purchaser will need to comply (i.e., meet demand) by creating its own reductions, at least initially. If this discharger needs a high fixed cost control strategy to create these reductions, the financial attractiveness of any potential future trade will be altered, probably diminished. In effect, the parties will have missed the market unless potential reduction suppliers have low incremental control costs that can compete with the discharger's lowered incremental control costs after its large fixed cost investment. In some cases, a discharger can use a high variable cost control strategy to create the reductions needed initially without incurring large fixed costs. In such cases, the discharger may still find it financially attractive to purchase reductions from another party in order to avoid continued implementation of its short-term, variable-cost control strategy (or in order to create additional margins for growth).

Alternative Scenarios

In light of the various factors influencing financial attractiveness and market participation, a watershed participant would be wise to assess market resiliency under alternative assumptions. This is especially important relative to the two factors that are likely to exhibit variability due to quantification difficulties and/or subjectivity—transaction costs and perceived risk. Spreadsheet programs allow for easy scenario playing, including: removing individual participants from the market; changing environmental equivalence ratios; or projecting alternative TMDL reduction requirements. Examining alternative scenarios may reveal, for example, that a large source unable to garner all reductions it needs from other watershed participants may decide to invest in controls and thereby eliminate almost all of the demand in the watershed, rendering trading unlikely or impossible due to insignificant remaining demand. You may discover other factors that could erode control cost differences beyond the level at which trading remains financially attractive. Identifying the most sensitive factors in your watershed will help you build a more robust understanding of trading viability in your watershed as well as highlight specific relationships to keep in mind as you move forward and design your market.